conditions. Many of these were on tuberculous subjects, and ether was therefore contraindicated.

Twenty-seven were general surgical cases; about half this number were appendectomies. The remainder were mainly hernias, drainage of abscesses and suturing of cuts, lacerations, etc. One was a thyroidectomy in a girl of 10 with anesthesia lasting two hours. One anesthetic was given to a child of 3, using an unreliable gas machine in an out-of-town hospital, for an appendectomy complicated by severe bronchitis.

Eleven were in the nose and throat department. These were all mastoids, and two of the patients were diabetics—one 10 years of age, the other 3. Nitrous-oxide-oxygen has not been used for tonsillectomies, as the dissection method for tonsillectomies is preferred, and fifteen to twenty minutes is rather long for satisfactory use of nitrous-oxide-oxygen when working in the back of the throat.

CLASSIFICATION AS TO AGES

There were eighty-five patients from 6 to 10 years of age, sixty-nine from 3 to 5 years, and forty-six of 2 years or under. The youngest was a baby of 11 months. The anesthestic was given for the radical removal of a sarcomatous kidney. That afternoon the baby was found standing up in her crib, laughing and shaking the crib gate as if nothing serious had happened to her that day.

REPEATED ANESTHETIZATIONS OF SAME CHILDREN

Quite a number of children had chronic trouble which needed repeated treatments. One boy with congenital bladder malformation had seventeen nitrous-oxide-oxygen anesthetizations over a period of two years, beginning when he was 2 years old, lasting until he was 4. One girl of 5 years had ten anesthetics within two months; three of them were for major operations and seven were for cystoscopies. One child of 3 years had nine anesthetics within six months. Another child of 2 years had eight anesthetics in three months. Two 5-year-old girls had five anesthetics each within two months. Four children had four anesthetics each, six had three each, and fourteen had two, while the remaining ones of the two hundred had one each. No untoward effects of repeated anesthetizations were ever noted. The children themselves became rather skeptical of the entire procedure and more reluctant to take the gas, but practically all could be reasoned with and understood that, after all, the gas was their best friend in the process of getting well.

TECHNIQUE OF ADMINISTERING ANESTHETICS

The gas machines employed were either the Ohio Monovalve or the McKesson. The procedure differs not the slightest from that used in administering to adults. In strong vigorous youngsters the induction is with pure nitrous-oxide lasting usually about forty-five seconds; then the mixture of nitrous-oxide-oxygen is given and continued to the end, when pure oxygen is given for about a minute.

In very pale, anemic, weak children the induction is made with a mixture of nitrous oxide and oxygen, the patient never being given pure nitrous oxide or allowed a too high percentage of nitrous oxide during anesthesia. Here also pure oxygen is given at the close.

Rebreathing and a closed system is used when relaxation is insufficient. Contrary to the old theory that children could not manage an anesthetic with a closed system, no difficulties at all have been found.

CONCLUSIONS

1. Nitrous oxide is the anesthetic of choice, especially in respiratory tract infections, tuberculosis, high fevers, diabetes, kidney pathology, and acute infections of the ear, nose and throat.
2. Children bear nitrous-oxide-oxygen anesthesia as well as adults, and there should be no age limit for its use.
3. Contrary to the old theory, children seem perfectly able to handle a closed system of anesthesia.
4. Technique of administration to children is the same as to adults.
5. Color changes in pale children are difficult to detect, and these children should receive a larger percentage of oxygen in the mixture.
6. No ill effects were noted from repeated anesthetizations of the same subject.
7. Two hundred administrations of nitrous-oxide-oxygen were given without ether, without complications and without a fatality.

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NON-INVERSION OF THE APPENDIX STUMP*

By FRANKLIN I. HARRIS, M. D.
San Francisco

DISCUSSION *by Charles G. Levison, M.D., San Francisco; Harold Brunn, M.D., San Francisco; H. A. L. Ryfkogel, M.D., San Francisco.*

IT is extremely disturbing to have our attention called to the startling fact that the mortality rate for appendicitis in the United States instead of declining as it should has been steadily increasing during recent years. Willis,[1] who analyzed the reports of the Bureau of Vital Statistics at Washington, concludes that in 1905 the death rate from appendicitis was 11.0 per 100,000, whereas in 1922, the last year for which figures are available, the rate was 14.4, or an increase of 30 per cent.

A disclosure of this nature should cause physicians to study the reasons for this increasing mortality and provide for their elimination. It is the purpose of this paper to review methods of treating the appendix stump as only one particular phase of the surgical technique which is believed to be responsible for a small but very definite percentage of the bad results.

The present methods of treating the appendix stump are mainly three (refer to Figure 1a):

(a) A preliminary ligation of the appendix at its base, its removal and the inversion of the ligated stump by a purse-string suture.

(b) The true inversion method in which, without any previous ligation at its base, the appendix

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is removed, the stump is inverted into the lumen of the cecum and covered over by a purse-string suture.

(c) The non-inversion method consists simply of the ligation of the appendix at its base, its removal and dropping back the cauterized stump into the abdominal cavity. I shall now try to show that theoretically and practically the inversion methods are dangerous and unsurgical procedures.

In the present popular method of treating the appendix stump it is not truly invaginated into the lumen of the cemum, but is buried in the wall of

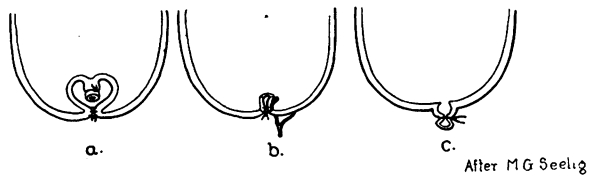

Fig. 1a

the cecum. True inversion is impossible, as the appendix has been ligated preliminary to its removal, and upon inversion a possibly infected stump has been buried in a closed cavity in the wall of the cecum. Even if the stump has been thoroughly cauterized and disinfected before its burial in the cecal wall, this method is, nevertheless, dangerous, for inevitably there is an exudate that forms about the necrotic stump. This exudate is bottled up in a cavity, the blood supply of which has been constricted by the inverting purse-string suture, so that the conditions are ideal for an abscess formation. This is not a purely theoretical objection, and occasionally a fatal outcome results from just this occurrence. The following case, which I found in reviewing the deaths from appendicitis in Mount Zion Hospital during the last four years, is cited to support this contention.

H. L., boy, aet 16, entered Mount Zion Hospital, January 5, 1922. Diagnosis, chronic appendicitis. He was operated on that date without any untoward incident. The appendix, after preliminary ligation of its base, was removed by actual cautery. The stump thoroughly cauterized and inverted with a purse-string suture of Pagenstecher by an operator of many years' experience and unquestionable skill. Patient returned to bed, and for two days following operation complained of considerable pain in the region of the incision. On the third postoperative day the patient's temperature started to rise, and from then on until his exodus on the tenth postoperative day he showed a typical clinical picture of spreading peritonitis. The autopsy confirmed this diagnosis of generalized purulent peritonitis, and there was seen in the wall of the cecum a huge abscess cavity in the region of the inverting Pagenstecher suture. There was no question but that the generalized peritonitis had arisen from the rupture of this abscess produced by the buried appendix stump.

It is surprising that this does not happen with greater frequency, but it does happen in a very definite percentage of patients, in many of whom the cause of death is not recognized as being due to this method of treating the appendix stump.

In the so-called true inversion, there is no such danger of cecal abscess, for the stump exudate drains directly into the lumen of the cecum. However, two other serious dangers must be considered here. We must remember that we do not pass a ligature around the base of the appendix previous to its removal, and the field of operation for that short period of time is in direct communication with the highly contaminated flora of the cecum. Theoretically, at least, it is not good surgery to expose the field deliberately to such a source of infection. But this is not the only nor the most serious objection to the complete inversion method. There is the still greater danger of secondary hemorrhage; for it has been shown that, in a fair percentage of cases, the meso appendix is absent, and the appendicular artery is in the wall and parallel to the long axis of the appendix and is caught only by ligating the appendix as a whole or dissecting out the vessel. Yet, the essential point of this method is not to ligate the appendix.

I have had no experience with this procedure, but Seelig [2] quotes two cases of hemorrhage from the bowel reported to him by Elsberg of New York and Charles Mayo following this method of treating the stump, in which the respective operators believed the hemorrhage came from the unligated appendicular artery. Hemostasis is as basic a law in surgery as is asepsis, so that this method must surely be considered unsurgical and dangerous.

The two methods so far described can be together criticized in that they both require the passage of a purse-string suture in the wall of the cecum. That this apparently simple surgical feat often results in a penetration of the bowel is not realized by the operator. We must remember that the wall of the cecum represents the thinnest portion of the entire intestinal tract. Roeder [3] has shown in a recent paper that, in one hundred appendectomies in which the inverting suture was used and immediately after the suture had been placed the needle and thread were dropped into a culture tube, in 88 per cent of those cases a positive growth was obtained, proving that the needle had penetrated the lumen of the cecum. Another possible result of the contamination of the purse-string suture is the occasional wound infection of the abdominal wall in interval and apparently clean appendectomies.

That we do not more often get into trouble as a result of this penetration is due to the remarkable protective powers of the omentum. The inevitable result, however, is a great incidence of postoperative adhesions, and Roder in this same paper has made a study of 105 appendectomies which later came to reoperation for various causes and in which he found that 85 per cent had adhesions around the cecum. He believes that the greatest cause of these adhesions is the trauma resulting from the passage of the purse-string suture.

There are many instances of acute appendicitis in which the base of the appendix is indurated, the wall of the cecum extremely friable, and the operator trained and taught to methods of inversion wastes considerable valuable time and further endangers his patient by repeated attempts to pass a satisfactory purse-string suture.

Anyone who has been around the operating room must have seen many cases in which, after an easy and rapid removal of the appendix, the operator spent considerable time trying to deliver an immobile cecum sufficiently for purpose of inversion. Such

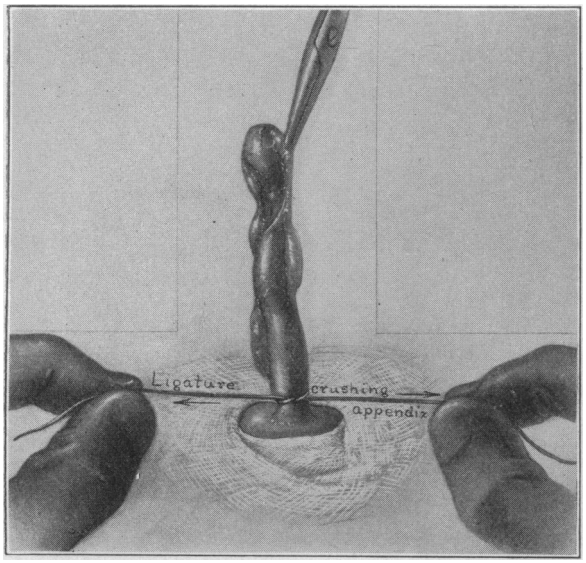

Fig. 1—After freeing the appendix from the meso appendix in the usual manner, it is held up by the assistant with a hemostat applied to its tip and, without any previous application of crushing forceps, a No. 2 chromic ligature is firmly tied about one-fourth inch from the base. This tie acts as a crushing forceps, and its ends are left long and held by the operator.

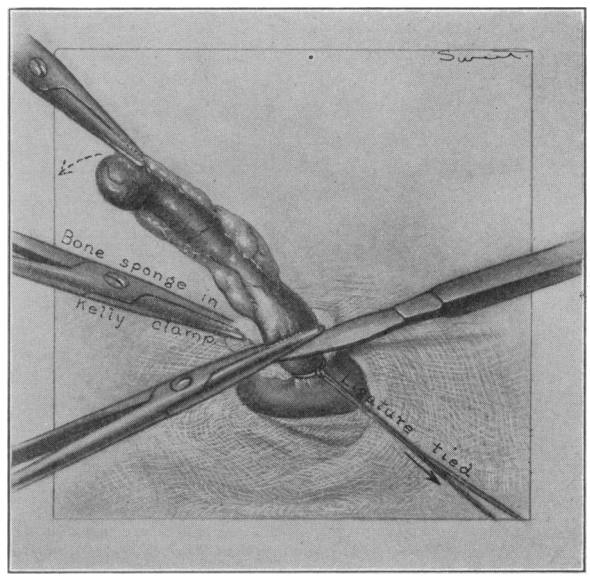

Fig. 2—A split gauze is carefully draped around the base of the appendix protecting the cecum, a straight Kelly clamp is applied about one-fourth inch distal to this tie, and a bone sponge is held in a forceps just behind the appendix by the assistant, and the appendix is severed by a knife, previously dipped in carbolic acid.

attempts are usually accompanied by much mauling and occasional tearing of tissues, with subsequent stormy postoperative meteorism.

Even assuming, however, that the cecum is not friable and is easily delivered into the operative field, there is still the danger of striking a small vessel in passing the purse-string suture and causing a spreading hematoma. We have all seen that happen, and often wonder if any harm results from this subserous hematoma. That harm does result occasionally is proved by the following case which I found in the review of deaths from appendicitis at the Mount Zion Hospital during the last four years.

Hospital, No. 36745. Woman, aet 23. Entered hospital, April 22, 1926, suffering from typical acute appendicitis. She was operated on the same day, a distended, infected appendix removed, the stump "inverted" in the usual manner. The operator noted in placing the purse-string suture that he had struck a small vessel which caused spreading hematoma in the wall of the cecum, but which seemed to be controlled before he closed the abdomen.

On the third day postoperatively, following an enema, patient complained of pain in the region of the incision. She looked badly, and blood count showed that hemoglobin had dropped from 75 per cent on day of entry to 57 per cent, and the red blood cells had dropped to 3,500,000. During the following three days the patient developed a septic temperature, looked worse each day, and on the seventh day postoperatively, a consultant advised reopening of the abdomen, as he felt there was an internal hemorrhage.

On April 29, 1925, at reoperation a large amount of free blood was found in the abdomen. The entire wall of the cecum was necrotic, there was a large amount of free blood and clots walled off by adhesions about the cecum, and a gangrenous mesentery. Patient expired despite transfusions and usual stimulation.

There seemed to be no question in the minds of the original operator and consultant of this particular case that the course of events could be traced directly to the small hematoma caused by the purse-string suture at the first operation.

There is still another reported remote danger due to the inversion method, with which I have not had personal experience. Thus Maloney [4] points out that there is a likelihood of the formation of inflammatory tumors of the cecum due to the buried silk or linen, and he has seen three such. Bunts [5] has shown the occasional formation of diverticuli following burial of the stump of the appendix. Case [6] has also shown by x-ray that there may be a stasis at the base of the appendix where a purse-string suture has been used.

Thus far I have tried to show that the inversion methods of treating the appendix stump are in theory and practice unsurgical. It now remains to prove that simple ligation with noninversion of the stump is a satisfactory and safe procedure. Those who are not familiar with this procedure can refer to the illustrations accompanying this article which show the exact technique of this method as I practice it.

One of the main theoretical objections to this method is the contention that the stump cannot be secure because mucous membrane is brought into apposition with mucous membrane. M. G. Seelig, in 1904, when this method was being popularized at Mount Sinai Hospital, New York, demonstrated by numerous microscopic sections taken through different appendices ligated in this manner that this objection is not valid. Microscopical section shows that the ligation forces back the mucous membrane for one-half inch, closing off the lumen completely; and further shows that the stump is fortified by four definite layers, from within out: (1) layer of polypoid lymphoid tissue; (2) thickened layer of resistant submucosa; (3) layer of muscularis; (4) layer of serosa, in addition to it being shut off by the infolding of the mucous membrane.

The next serious objection to this method is that it leaves free in the abdominal cavity a potentially infected stump. It has been proved by cultural tests that the application of pure phenol is sufficient to thoroughly disinfect the stump; so that the conten-

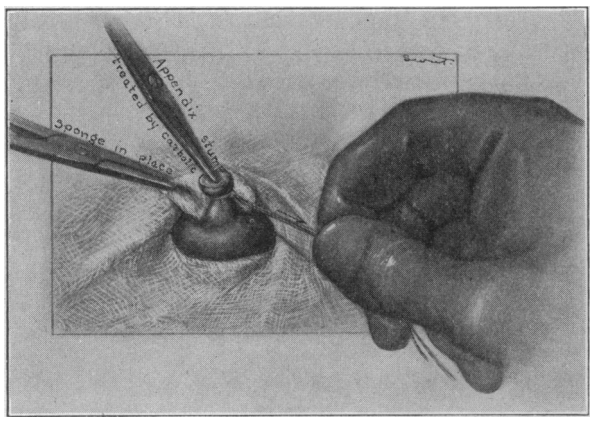

Fig. 3—The funnel-shaped stump which is now held by operator by means of the original tie is thoroughly cauterized by the application of the tip of a straight hemostat which has been dipped in a small basin of phenol in the same manner as a pen is dipped in ink, the bone sponge and gauze protecting the cecum from any excess of phenol. When the stump is whitened by the application of the phenol, which usually occurs after two applications, we can assume it is practically sterile.

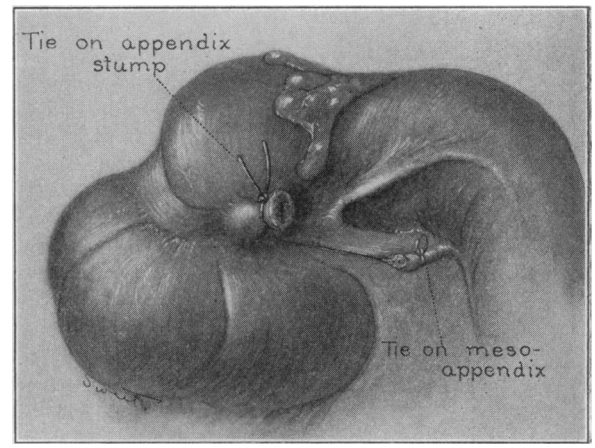

Fig. 4—The ends of the ligature are cut about three-fourths inch long, and the stump is dropped back into the abdominal cavity, completing this step of the operation.

tion that we are leaving an infected stump in the abdominal cavity does not hold good. It is true that there is certain to be some secretion poured out about this necrotic stump, but certainly there is no structure in the human body that is better able to take care of this secretion than the peritoneum.

Another argument against this method is that the uncovered stump will result in the formation of dangerous adhesions. Howard Lilienthal,[7] first in 1903 in a published report, and again recently (1925) in personal conversation, is very emphatic in his contention that this method is the *only* way in which dangerous adhesions can be prevented. He has examined many cases at postmortem from this point of view, and from his study concludes that the stump is cast off in three to six days, leaving a small, smooth, dimpled spot to mark the point of origin of the appendix. Furthermore he has noted that the operative region about the cecum was practically always free from adhesions.

Maloney of Cincinnati, who has had experience in 3500 cases treated by noninversion, states that in reoperative cases there never has been an adhesion seen, nor has the cecal scar been visible.

Horsley,[8] who also advocates non-inversion, makes the following statement: "I have had occasion to reoperate for other causes on a number of patients on whom the stump of the appendix has been treated in this simple manner, and in no instance have I found a serious adhesion or any other complication. In the majority of cases in which the stump has been buried I have found either unusual adhesions or a lump in the bowel or else a diverticulum, such as had been described by Bunts."

The crux of the whole argument is that if adhesions form around the site of an inversion, they form to stay and make trouble; whereas if they attach themselves to the stump which has been ligated tightly enough their traction on that stump will tend to cause its separation from the cecum, thus doing away with painful adherent adhesions and eliminating a possibility of an obstruction due to a band.

Finally, the criticism is made that the ligature on the stump of the appendix may blow off. Such a possibility should be given as much consideration as the surgeon gives to the possibility of a ligature blowing off of a large blood vessel. The stump of the appendix is soft, and the ligature usually sinks in, snug and securely; better in fact than it does on a good-sized artery. Moreover, the pressure within the cecum never begins to approximate the blood pressure; so that a surgeon who feels capable of safely ligating a blood vessel should be able to safely ligate the appendix stump.

However, the objections enumerated are all theoretical, for this method of treating the stump of the appendix has been used by the entire surgical staff of Mount Sinai Hospital in New York City, in thousands of cases during the last twenty-five years without a single cause for regret. My own personal experience at that hospital in observing over a thousand cases treated in this manner, as well as a small number that I have done privately and on the service of Harold Brunn at the Mount Zion Hospital of San Francisco, has failed to substantiate any of the criticisms directed against this procedure, nor have I noted any other reason for abandoning this method.

Since my first introduction to this method I have always believed that the incidence of fecal fistulae would be less if this method were more universally adopted. Just recently Colp[9] has analyzed about 3000 cases of acute appendicitis in which there was noted an incidence of 1.1 per cent fecal fistula compared to an incidence of about 5 per cent from other published statistics, and he believes that the lowered incidence in his series may be largely due to the non-inversion method of treating the appendix stump.

In conclusion, I have tried to show that the inversion methods of treating the appendix stump are dangerous, unsurgical, and unnecessary procedures for the following reasons:

1. There is danger of abscess formation in the wall of the cecum.

2. In the true inversion method there is danger of secondary hemorrhage from the unligated appendicular artery.

3. These methods are not applicable to every

case, require more time and offer greater technical difficulties.

4. They are largely responsible for the postoperative appendectomy adhesions and probably give a greater incidence of fecal fistulae.

5. They are the cause of remote complications such as inflammatory tumors of the cecum and diverticuli.

6. Judging from the review of deaths from operative appendicitis in Mount Zion Hospital during the last four years, and this review can be taken as typical of the average general hospital throughout the country, we can charge inversion methods of treating the appendix stump as being responsible for a definite percentage of our fatal results.

On the other hand, non-inversion offers us a method to which none of these objections can be made, and in addition it is undeniably simple, time saving, and adaptable to practically all cases.

710 Medico-Dental Building.

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DISCUSSION

CHARLES G. LEVISON, M. D. (870 Market Street, San Francisco)—My attention was first called to this technique during an eastern trip about 1904. I was much impressed at the time, and had decided to adopt the method. At this time in conversation with the heads of two large clinics, I was informed by one of them that he had lost a patient because of a slipping of a ligature, and by the other that he had had a death from tetanus apparently due to the incomplete sterilization of the stump.

These experiences destroyed my interest in the procedure which I have never employed. I feel, however, that the method has great value because it has been practiced, to my knowledge, by many of the important operators in this country with satisfying results, for if the results had not been satisfactory the operation would have been discarded.

In my opinion it offers two definite advantages. First, the operation is easier because of its simplicity and rapidity. Second, and the most important, is the avoidance of subperitoneal hemorrhage consequent upon the puncture of a vessel. This is a potential danger always present in the purse-string technique.

HAROLD BRUNN, M. D. (384 Post Street, San Francisco)—Doctor Harris has given us very convincing arguments in favor of the noninversion method of treating the stump of the appendix.

We are all apt to follow procedures that we have become accustomed to use and that seem satisfactory without actually considering methods that may be an improvement and at the same time simplifying the technique.

The long series of cases in which this method has been used, and the test that has been given it in some of the best clinics in America immediately gives us confidence in the procedure.

Until Doctor Harris brought this simplified technique to my attention I had always used the inversion method with Pagenstecher or catgut stitch which most surgeons usually employ. For the past year I have adopted in all my cases, without exception, this method of simply tying off the appendix with chromic gut and carbolizing the stump thoroughly. The results have been most satisfactory, and I believe, taking it all in all, the convalescence is even smoother than with the inversion stitch.

The method has many advantages. It is extremely expeditious—I should say it consumes at least half the time of the other method. There is much less handling of the bowel and the danger of puncturing the lumen of the bowel or inverting a septic focus, or puncturing a vessel with hematoma, is entirely avoided. In pelvic work when the appendix is to be removed as a matter of routine, not because of disease, this saving of time makes it a satisfactory procedure. The removal of an appendix through a hernial sac, which often becomes necessary, is infinitely simpler with this technique.

My experience with the method is sufficient at the present time to warrant recommending it, and I am convinced that I shall never return to the older method of inversion.

H. A. L. RYFKOGEL, M. D. (516 Sutter Street, San Francisco)—About twenty-five years ago I saw Wyeth of New York remove an appendix by ligation without inversion, and heard him argue that it was the only rational method. From that time until five years ago I used this method in all cases where inversion was difficult because I realized that, so long as the method had been demonstrated by so able a surgeon, it could not be good surgery to add unnecessary trauma where the wall of the cecum was thickened and friable from inflammatory infiltration or where the stump was difficult of access. I continued to use the inversion method when it was easy.

About five years ago a patient on whom I had performed an appendectomy for recurring appendicitis in the interval developed a general peritonitis, and I believe the purse-string stitch was the cause.

Since then I have, without exception, used the simple ligation method described by Doctor Harris, and have no reason to repent my change. Lately I have been using the cautery knife to sever the mesentery and the appendix, and to sterilize the stump. This further simplifies the procedure.

Dr. Franklin Harris deserves much praise for his clear and thorough discussion of so important a subject and for so lucidly demonstrating that tradition still holds the majority of operators to an unsurgical technique.

Nation has Learned Lesson from State—The so-called "Monkey Trial" in Tennessee had at least one salutary effect on the people of the United States, according to Professor Samuel J. Holmes of the Zoology Department of the University of California, who is chairman of the Committee on Freedom of Teaching in Science of the American Association of University Professors.

Professor Holmes, through information sent to him by state universities, finds that although twelve states have had anti-evolution bills before their legislatures during the past year similar to those in force in Tennessee and Mississippi, not one was passed. In every case the legislators decided against any measure which would curtail the work of scientists.

The states involved were North and South Carolina, Oklahoma, Missouri, Arkansas, North Dakota, Minnesota, West Virginia, California, Delaware, Alabama, and Louisiana.